

## PATENT SPECIFICATION.



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169,063

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## COMPLETE SPECIFICATION.

## Improvements in Electrical Apparatus for the Electro Chemical Treatment of Hydrocarbon Vapours.

I, LOUIS BOND CHERRY, a citizen of the United States of America, of 1011, Republic Building, Kansas City, County of Jackson, and State of Missouri, U.S.A., Electrical Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

10 This invention relates to electrical apparatus for the electro-chemical treatment of hydrocarbon vapours; and the objects and nature of the invention will be readily understood by those skilled in the art in the light of the following explanation of the accompanying drawings illustrating what I now believe to be the preferred embodiment of my invention from among other forms, constructions and arrangements within the spirit and scope thereof.

An object of the invention is to provide improved apparatus for the treatment of hydrocarbon compounds while in the vaporized or gaseous state.

25 A further object of the invention is to provide apparatus whereby hydrocarbon vapours and gases can be thoroughly and effectively subjected to the influence of certain electrical discharges.

30 A further object of the invention is to provide apparatus embodying certain vapour or gas treating passages having electrical heating means under the control of the operator to bring about certain changes in the character or nature of the vapours or gases passing through said passages.

40 A further object of the invention is to provide certain improvements in arrangements of elements and in constructions whereby a highly advantageous and

improved apparatus for the treatment of hydrocarbon compounds will be produced.

With those and other objects in view my invention consists in certain novel features, arrangements and combinations as more fully and specifically set forth and pointed out hereinafter.

Referring to the accompanying drawings:—

Fig. 1 diagrammatically illustrates apparatus of my invention in connection with a diagrammatically illustrated crude oil still, the still being shown in section and the treating chambers or ducts of my invention in elevation.

Fig. 2 diagrammatically illustrates one of the treating chambers or ducts in vertical section.

Fig. 3 shows the treating chambers in cross section.

In the drawings, a crude oil still 1 is diagrammatically illustrated. This still can be of any ordinary or suitable construction and can be heated by any suitable means or in any desirable manner. Any usual or suitable means is provided for supplying the oil to the still, and the still can be provided with the usual or any suitable intakes and outlets and with the usual or any suitable accessories and connections.

If so desired, the still 1 can represent the ordinary, horizontal cylindrical, or any suitable crude oil still such as commonly employed in oil refineries for the fractional distillation of crude oil, mineral and other oils, and the apparatus of my invention can be connected up with such still particularly for use in treating vapours derived from the residue remaining in said still after the natural crude benzene has been vaporized and passed

from the crude oil, in accordance with the common practice.

I show the treating chambers or passages of my invention interposed, in the vapour passage, from the still to the condenser. In the drawings, any suitable condenser 2 is diagrammatically illustrated and the products discharged from the condenser enter any suitable trap or separating device 3.

In the example illustrated in the drawings, the vapour and gas treating apparatus comprises four upright parallel units coupled together in series so that the vapours from the still flow through pipe 4 into the upper end portion of the first unit and these units are so coupled together that the vapours flow longitudinally throughout the length of each unit downwardly through one unit and upwardly through the next and from unit to unit, and finally discharge into the condenser through pipe 6 from the upper end of the last unit of the series. However, I do not wish to so limit all features of my invention.

In the particular example illustrated although I do not wish to so limit all features of my invention, each upright treating chamber is mounted on a suitable base 7 and comprises a bottom metal cross or four-way pipe union or coupling 12, the lower arm of which is closed and bolted to the base and forms the depending bottom end of the chamber; an upright straight cylindrical metal pipe-length 6 bolted to and forming an upward continuation of the top arm of the coupling 12, a metal pipe union or T coupling 10 forming an upright continuation of the pipe 6 and having its lower vertical arm bolted to the upper end of pipe 6; and a hollow top head 8 forming an upward continuation of the union 10 and at its lower end bolted to the upper arm of said union. The upper end of hollow head 8 is provided with clamping plates and an insulator 9 to close the projecting upper end of the treating chamber unit. The insulator extends through said plates from the exterior thereof and depends longitudinally and centrally within the head.

The lateral or horizontal arms of the Y unions 10, are utilized for coupling vapour and gas delivery pipe 4 to the first unit, vapour offtake pipe 5 to the last unit, and cross connection pipe 11 to the upper ends of the second and third units to provide for flow of vapours from the second unit to the third unit.

The lateral or horizontal arms of the four way unions 12 are arranged to extend

forwardly and rearwardly and the front ends of the forwardly extending arms are closed by removable plates or covers 12a whereby access can be readily gained to the interiors of the lower ends of the units for repair or inspection or for cleaning purposes. The rearwardly extending arms of the fourway couplings are utilized for coupling and securing the cross connection pipes 13 that provide the vapour passages from the lower end of the first unit to the lower end of the second unit, and from the lower end of the third unit to the lower end of the last unit. The cross connections 13 as shown are horizontally arranged and U shape in form to constitute return bends. These return bends are removably bolted to the rearwardly projecting lateral arms of the unions 12 whereby either return bend can be removed when removal of plate or plates 12a, will not afford the necessary access to the interior of a unit for inspection, repair or cleaning or for removal of broken electrodes or other parts, or for other purposes.

If so desired, the traps or pockets formed at the lower ends of the units by the depending arms of unions 12, can be provided with valved drain pipes 14.

I preferably provide suitable pyrometers 35, or other suitable means, to indicate temperatures at various points, such as within the still, the vapour offtake from the still, and the vapour offtake from the treating chamber, although I do not wish to so limit my invention.

The vaporous or gaseous compounds passing through the treating chamber are subjected to the electrical treatment set forth in the specification of my Letters Patent No. 104,330.

In the drawings, I show each treating chamber unit provided with a central longitudinally arranged electrode formed by a comparatively fine wire 16 of good conducting metal extending throughout or approximately throughout the length of the unit. This wire depends from the insulator 9 and at its lower end carries a weight 17 of insulating material which acts as a plummet in holding the wire taut and straight and in preventing electrical discharge from the wire extremity. The metal walls 8, 10, 6 and 12 of the several treating chamber units are of good electrical conductor material and said walls of the several units are electrically connected together or to ground.

The several electrodes 16 are suitably connected up with an operating circuit to produce the silent discharge of a high frequency oscillatory electric current

back and forth between the electrodes and the adjacent walls of the treating chamber units and through the vapours and gases flowing through chambers *a* and transversely to the direction of the flow thereof.

Any suitable electrical connections and instrumentalities can be provided for this purpose. For instance, in Fig. 1, I have diagrammatically illustrated circuits and instrumentalities, from among others, that might be utilized for producing the silent discharge desired from the power derived from any suitable source 20, 21, of alternating electric current.

In the example, illustrated, I show the opposite terminals of the high frequency oscillatory bipolar electric current circuit connected through insulators 9 with different sets of electrodes 16 so that the silent discharge from each set of electrodes 16 will flow from said electrodes across chambers *a* in which they are located to the walls thereof and through said walls to the walls of the remaining chambers and across the spaces *a* thereof to the other set of electrodes 16. I thereby attain maximum electrostatic balance in the high frequency circuit.

I provide means for subjecting the vapours while in the treating chambers *a* to a comparatively high degree of heat, and while this heat can be generated and applied (according to the broad features of my invention) in any suitable manner and by any suitable means, yet other features of my invention contemplate the generation and application of this heat through the medium of certain electrical means and instrumentalities embodying electrical coils. To this end, the tubular walls 6 of the chambers *a* are formed of iron, steel or other suitable metal, and each body 6 is exteriorly surrounded by a coil or solenoid 15 extending longitudinally thereof and approximately throughout the length of said body. Each coil 15 is composed of copper or other good electrical conductor wire electrically insulated from body 6. I have found it desirable to employ suitable fireproof or high temperature insulation in which good conductors 15 are encased or electrically insulated from the tubular bodies 6 which they surround.

The exterior solenoids 15 of the several tubular bodies 6 are electrically connected together in any suitable manner, and each solenoid is not a high resistance or in that sense a heating coil, but is composed of a good conductor and when the proper or required alternating current is passed

through the spiral coils thereof, the tubular metal wall 6 of the treating chamber surrounded by said coils will be heated by induction.

In the diagram illustrated, I show the solenoids 15, connected with any variable potential generator or with a suitable alternating power circuit 33 through the medium of suitable instrumentalities including a controller for the heat generating current comprising an autotransformer or other suitable transformer 22, the secondary of which is provided with taps 23 leading to the various fixed contacts 24 of the rotary switch which contacts are arranged progressively around the switch centre to successively receive the manually adjustable switch contact or blade 25 which is rotatable about the switch centre to progressively increase or decrease the current which flows in the heating coils with a consequent increase or decrease of the temperature of the walls 6 of the chambers *a*.

Where the apparatus described is utilized to carry out the method of my aforementioned patent, any suitable hydrogen carrying gaseous agent or vapour is discharged into the hydrocarbon liquid in the still 1, through the medium of perforated pipe 28, arranged in the bottom of the still so that said agent rises through the liquid in the still and is mechanically mixed with and heated to the same temperature as the vapour rising from said liquid. This mechanical vaporous mixture passes from the still through pipe 4 into the electrical treating apparatus. The walls 6 of the treating chambers *a* are usually maintained at a comparatively high temperature by the alternating current in the coils 15 and the vaporous mixture in said chambers is thereby subjected to said high temperature while said vaporous mixture is subjected to the hereinbefore mentioned high frequency electrical discharge. The molecular structures of the vaporous mixture are thereby changed without substantial loss by by-products, to produce a product having a higher percentage of hydrogen.

Natural, coal or hydrogen gas, superheated steam or a mixture of superheated steam and natural or other gas can be discharged into the mineral oil in still 1, to provide the hydrogen carrying agent. I show a valved supply pipe 29 through which superheated steam can be supplied to pipe 28 where desired, simultaneously with natural gas supplied through valved pipe 30 or either pipe 29 or 30 can be shut off to permit discharge

of either steam or gas into the still without the other.

With the apparatus as disclosed, the still can be operated under low or approximately atmospheric pressure, and the walls 6 of the treating chambers can be maintained at approximately a red heat or high heat by the alternating current in coils 13, whereby certain advantages are attained. I also attain certain advantages by providing the greatly extended path through which the vaporous mixture must pass and wherein it is subjected to heat and the electrical discharge. In the embodiment shown this extended path is formed by the plurality of elongated units embodying the tubes 6.

Obviously, the number of units can be increased or decreased for any given installation so that the vaporous mixture will be subjected to the electrical discharge for the desired length of time and throughout a path of the desired length.

I also gain advantages, in the specific apparatus, by forming an elongated treating chamber within a pipe length 8 that is surrounded approximately throughout its length by the alternating current coil 15, inasmuch as the pipe length is heated to a higher temperature at the centre of its length than at its end portions, and for some reason that I cannot now explain, the process is thus carried on with better results than where the vaporous mixture is not subjected to varying temperatures in the treating chambers.

With the apparatus of this invention, I can vary the character of the product by varying the heat of the walls 6 of the treating chambers; instead of by manually controlling the electric current to change the frequency of the electrical discharge. By operating the apparatus with the walls 6 of the treating chambers at approximately a red heat, I can increase or decrease the heat of said walls by manipulating the switch handle 25 and thereby increase or decrease the temperature of the vaporous mixture passing through said chambers and consequently vary the electrical resistance said mixture offers to the passage of the silent discharge.

Within certain limits variation of the temperature within the treating chambers has the same effect on the vaporous mixture as the direct variation of the frequency of the electrical discharge.

The character of the resulting product can also be changed within certain limits, by varying the length of time the vaporous mixture is subjected to the electrical discharge within and the heat of

the treating chamber *a* and this length of time can be changed by varying the speed or velocity of flow of the mixture through said chamber. Where the still is operated at about atmospheric pressure and the temperature of the oil in the still is just below the boiling point, so that the speed or pressure of the gas entering through pipe 28 is necessary to carry the vapours from the still and into chamber *a*, the speed of flow of the vapours through chamber *a* can be manually controlled by manipulating the valve in the gas supply pipe to increase or diminish the volume and pressure of the gas admitted to the still.

The apparatus of my invention is not limited to use in carrying out the hereinbefore described method but also constitutes an efficient equipment for "cracking" of oils in the vapour state, where natural gas, or other hydrogen carrying agents are not mixed therewith, and particularly for the production of the aromatic hydrocarbons and for operation under high pressure and temperatures.

Where used for "cracking" oils or for the production of aromatic hydrocarbons, the high frequency electrical discharge in connection with the heated walls of the treating chamber, is effective in breaking up the molecular structure of the vapour and prevents excessive deposit of carbon on the surfaces of said walls, the carbon being carried over by the vapour and settles in the tank where the final product is stored.

Steam can be utilized to supply the hydrogen required by the hereinbefore described method. The steam is discharged into the hydrocarbon liquid in the still through pipe 28 and passes into the treating chamber with the hydrocarbon vapour. Under the influence of the high temperature of the hot metal walls and the high frequency electric current discharge in the treating chamber, the steam is decomposed, the hydrogen uniting with the hydrocarbon vapour and the oxygen uniting with such carbon as may be released to form carbon monoxide (CO) and this carbon monoxide can be burned in the furnace under the still.

It is evident that various changes, modifications and variations might be resorted to in the forms, constructions, arrangements and combinations of the parts described without departing from the spirit and scope of my invention and hence I do not wish to limit myself to the exact disclosures hereof.

Having now particularly described and

ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

- 5 1. Apparatus for treating hydrocarbons comprising in combination, a still for vapourizing the liquid hydrocarbons, a condenser, and a conduit for conducting the vapourized products from the still to the condenser, said conduit embodying an elongated treating chamber separate from the still, means for maintaining the wall of said chamber at high temperature, for example, approximately a red heat, and means for subjecting the vapourized products while passing through the said chamber to a high frequency electric current discharge while said products are under the influence of said hot wall.
- 20 2. In apparatus according to Claim 1 a solenoid exteriorly surrounding and arranged longitudinally of the elongated treating chamber and insulated therefrom and arranged to highly heat the same by induction, said solenoid being composed of a good electrical conductor, with or

without means for controlling said current to vary the temperature of said unit.

3. Apparatus according to Claim 1 or 2 wherein the conduit forming the treating chamber comprises several tubular units connected in series by cross connections to cause the mixtures to flow longitudinally through said units in succession, said cross connections comprising a removable return band whereby access can be gained to the interiors of the units connected thereby.

4. In apparatus according to any of the preceding claims, a pipe for steam, hydrogen or other gas discharging into the still below the liquid level therein.

Dated this 20th day of July, 1920.

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FIG. 2.

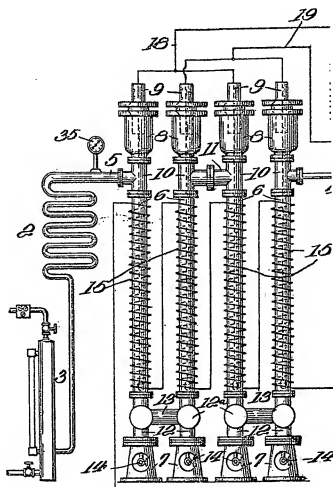
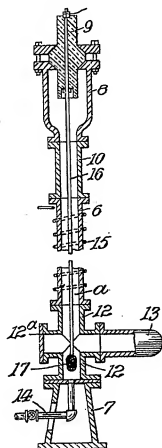
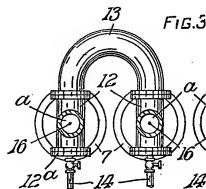
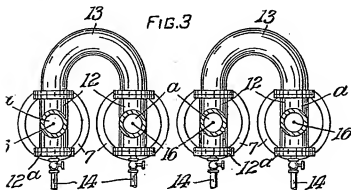
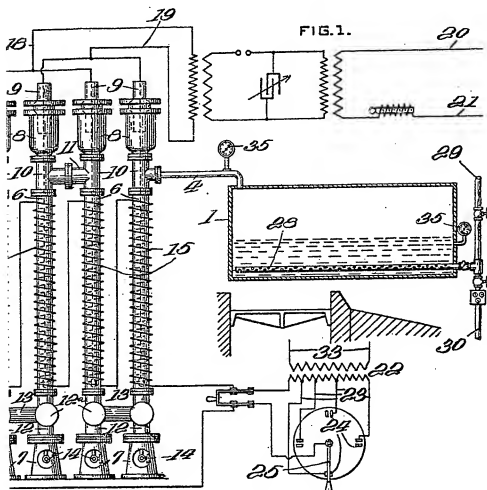


FIG. 5



[This Drawing is a reproduction of the Original on a reduced scale.]



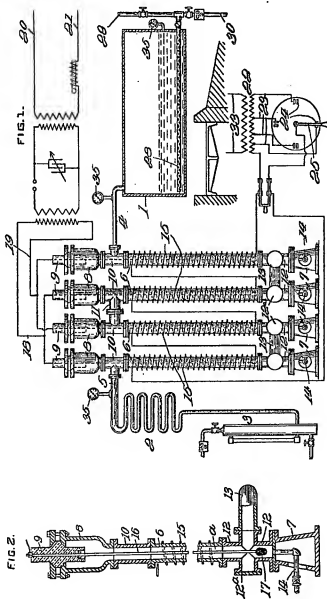


FIG. 2.

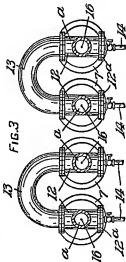
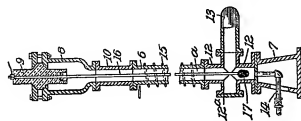


FIG. 5.

*(This Drawing is a reproduction of the Original on a reduced scale)*